REPORT ON RECLOSING CIRCUIT BREAKER QUESTIONNAIRE

NOT FOR PUBLICATION

U. S. DEPARTMENT OF AGRICULTURE
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1. Introduction

During December, 1945 a sampling questionnaire was sent out to about 250 REA borrowers, requesting information and comments on reclosing oil circuit breakers. Instead of asking for detailed failure records or operating experience, an effort was made to obtain from the managers and superintendents a general reaction to the application and performance of the reclosing breaker, and suggestions for improvement. 133 systems, representing 34 states, replied to the questionnaire. This report summarizes the comments received.

2. Question 1

"Using your best judgment, do you think that there should be additional single-pole breakers on your system? If so, how many?"

Replies:

109 systems indicated a desire for 2,487 single-pole breakers.
10 systems desired such breakers, but indicated no specific number.
14 systems did not desire breakers. Of the latter systems, most replied that they had sufficient units at present.

3. Question 3

"If the answers received from managers should indicate the need for it, it is reasonably certain that manufacturers would bring out the following designs:

Two single-pole breakers, of the same design as your present breakers, would be coupled to make one double-pole breaker for a Vee circuit. Similarly, three single-pole breakers would be coupled to make one three-pole breaker for a three-phase circuit. When a short occurs between one phase and the ground, only one single-pole breaker would trip out, the second and third remaining closed. Only after one single-pole breaker remains permanently open after the reclosing cycle would the breakers on the other phases trip out automatically.

a. Approximately how many such double-pole breakers would you require on your system during the next two years?_______

b. Approximately how many such triple-pole breakers would you require on your system during the next two years?_______ "

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Replies:

24 systems indicated a desire for 151 double-pole breakers.
30 systems indicated a desire for 174 triple-pole breakers.
95 systems replied that no double or triple pole breakers were wanted.

4. Question 4

"Would you consider it preferable on Vee circuits or three-phase circuits, to use two or three (respectively) single-pole breakers without coupling them together?" "If so, why?"

Replies:

95 systems answered yes.
32 systems answered no.
The remainder were noncommittal.

In answering the second part of the question, many reasons were given by those desiring the single-pole breakers. The greatest number felt that it was undesirable to interrupt service to members on the other two phases because of trouble on one phase. Other reasons were as follows:

a. With single-pole breakers the faulted phase is apparent, while with multi-pole breakers it would be more difficult to ascertain the phase in trouble.

b. Single-pole units are smaller and easier to mount.

c. Single-pole units result in fewer stock items.

A few of the systems which answered "yes" to this question also reversed themselves somewhat by stating that multi-pole breakers might be necessary if three phase load increased sufficiently or were predominating in importance.

Those desiring the three-pole breakers stated the reason as being, "to prevent single phasing of three phase motors." Most of these systems had irrigation or other large three phase loads.

5. Question 2.

"What suggestions if any, can you offer for improving them?" (Single pole breakers) The replies to this question were naturally quite varied. 40 systems answered "none." 5 of these indicated that their answer was "none" if the design of the breaker was equivalent to the newer tank type breakers.

Some of the more important suggestions are summarized as follows:

a. In regard to time delay on breaker opening:

5 systems wished to coordinate branch line fuses with the sectionalizing breaker so that the breaker would operate on temporary faults, with the fuse operating on permanent faults.

5 systems desired greater time delay in breaker opening so that the load could be picked up without tripping the breaker when re-energizing a line.

10 systems desired time delay in breaker opening, but indicated no reason.

2 systems suggested an adjustable time delay.

b. Tank construction:

20 systems stated a preference for the grounded tank with top bushing type of construction.

2 systems suggested that the bushing on the bottom of the porcelain tank be insulated.

No system stated a preference for the porcelain or live tank type breaker.

c. Indicator:

8 systems suggested an indicator more easily seen from the ground.

2 systems advocated a red light indicator for a lock-out position.

d. Mounting:

9 systems desired a more simple mounting arrangement, most of these specifying a pole mounting bracket.

e. Lightning protection:

8 systems felt that the lightning protection on the breaker or around the operating coil should be improved.

f. Mechanism and contacts:

10 systems suggested improved mechanical parts and better contacts. Most of the contact trouble seemed to be with the older dead tank type breakers. Most of the mechanical trouble were with the older live tank top breaker gears.

g. Miscellaneous:

(1) 4 systems desired a larger number of breaker ratings to be available.
(2) 2 systems requested a greater maximum load rating and interrupting rating. (Florida and Tennessee)
(3) 6 systems requested the mechanical "isolator" for disconnecting branch lines beyond breakers.
(4) 1 system suggested a means of opening and closing the breaker from the ground.
(5) 1 system found difficulty in detecting high resistance ground faults. (Tennessee)
(6) 2 systems indicated that there was difficulty with the hydraulic operated type breaker in the winter.
(7) 1 system suggested better rust-proofing on metal tank designs.

6. Conclusions and Recommendations

It is apparent from the questionnaire results that REA systems are generally satisfied with the operation of the reclosing circuit breaker. On the whole little concern is given to difficulties with circuit breakers performances. For improvements, the consensus seems to be that the design should have, (1) a "dead" case with bushings through the top, and (2) time delay on all or the final openings.* On one design, the first and second fast openings and third and fourth time delay openings make it possible to use fuses beyond the breaker to clear permanent faults, and should also lessen or eliminate the difficulty which heretofore has been encountered with the fast opening breaker tripping on initial inrush current when re-energizing.

It should be cautioned, however, that field experience with the newer dead tank type breakers has been very limited, and many "bugs" may develop with it. In particular, the insulation to ground of the metal cased breaker is probably inferior to that of the porcelain tank type breaker, and it can be expected to become poorer as the oil becomes sludged. Hence, more insulation failures probably may be expected on the dead tank breaker as time goes on. In addition, the metal-cased breaker is subject to rust.

With regard to the opening time delay, too much delay will cause lack of coordination with transmission line relays, which are steadily becoming higher speed. There should be enough delay to pick up load on re-energizing, but the shape of such re-energizing transient curves is not yet known. A good deal of research is still necessary on this subject, and it is questionable if time delay in breaker openings will be the complete answer to this problem. From some utility experiences, it will not be.

* (This type of operation was suggested in an AIEE paper of 1943, "Experience with Oil Circuit Breakers on REA Systems.")

Some doubt of the ability of the hydraulically-operated breaker to operate properly in cold weather, or if the oil becomes contaminated, has also been expressed. Two REA systems do complain of such troubles, but apparently the matter is not serious or widespread as yet.

Most systems prefer the single-pole breaker to the multi-pole device. This is only logical with the predominance of single phase load to three phase load, however, it is not unreasonable to expect a greater demand for multi-pole breakers as the systems expand their poly-phase circuits. One hazard with single-pole breakers or fused cut-outs probably frequently overlooked, is the fact that an opened phase wire may have as high as half normal line-to-ground voltage on it if there are three phase transformer banks along the line connected wye delta with floating neutral.

Also it is not known how carefully the system management checks three phase motor installations to make sure that the motor protection is adequate.

However, the advantage of maintaining service to as many consumers as possible is a great one, and it would seem that single-pole devices could be used in most cases if the above factors are borne in mind, unless the load is quite predominately three phase. The emphasis on development should be on the single-pole unit. When a three-pole unit is developed, some attention should be given to providing means to distinguish the faulted phase.

The requests for more and more breakers shows the awareness of the systems for adequate sectionalizing. But putting more breakers in series makes for considerable difficulties in design of such devices. The solution to these problems may be in limiting the length of line from one substation, and in developing new types of devices, actuated perhaps by other factors than fault current.

Considerable research needs to be done on the proper time-delay needed, the proper size of transformer fuse to coordinate with the breaker, the optimum number of breaker openings, and a host of other problems.